CEREAL SCIENCE today

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OF INTEREST THIS MONTH

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OPERATIONS RESEARCH

THE ZELENY SEDIMENTATION TEST

6th Edition

CEREAL LABORATORY METHODS

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Any discussion of this world renowned book has to be directed to two separate groups — those unfamiliar with earlier editions and those who regularly use this volume in their laboratory as a standard methods source.

To the former group it should be pointed out that CEREAL LABORATORY METHODS has been published by the American Association of Cereal Chemists since 1922. It represents the work of cereal chemists employed in industrial, academic, and government laboratories throughout the world. It contains the accepted analytical methods used by these chemists for determinations on cereal or cereal by-products.

Former users will be interested in learning that the new 6th edition will be some 40% larger than the 1947 volume and that over 50% of it will be new and/or revised material. The most significant change will be the new style of presentation. No longer will the book be divided into chapters, each concerning a particular subject such as wheat, bread, flour, feed, etc. Instead, the 6th edition will be divided into 100 categories consisting of "determinations" such as the determination of acids, of amylase activity, of calcium, of moisture, of fat, etc. Each of these major categories will be further divided into specific tests.

Many new methods have been included in the 6th edition which were not available in 1947. Among these are methods for the testing of prepared mix ingredients, of physical properties of doughs, of bread staling, etc.

The 6th edition of CEREAL LABORATORY METHODS has been designed for easy use in the laboratory by both the chemist and technician. Ample details are provided for the preparation and standardization of all solutions. Apparatus and equipment are clearly described and special items are accompanied by name of manufacturer. Three separate indices are designed to provide [illegible] in the book.

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AMERICAN ASSOCIATION OF CEREAL CHEMISTS
University Farm, St. Paul 1, Minnesota

White Flour in the U.S.A.—

Enriched* with Vitamins and Iron for Better Nutrition

by Science Writer

This article is one of a series devoted to the enrichment of family white flour, white bread and rolls, corn meal and grits, macaroni products and white rice.

The enrichment of family white flour with thiamine, riboflavin, niacin and iron by American millers is a major success. It has made great contributions to better health in the United States by improving a staple food.

Since the start of the program in 1941 by millers, voluntarily, the evidence is conclusive that enrichment not only has reduced the number of cases of certain dietary diseases but also is promoting the mental and physical vigor and well-being of the U. S. population generally. Because of its demonstrated value, the principle and practice of enrichment have been applied to other foods made from grains: corn meal and grits, white rice, macaroni, spaghetti, noodles, pastina, farina—and, of course, to white bread and rolls.

Doctors and diet experts have long supported white flour enrichment. The Council on Foods and Nutrition of the American Medical Association and the Food and Nutrition Board of the National Research Council are on record as endorsing the practice.

The legislatures of a majority of the States plus Hawaii and Puerto Rico have enacted laws which make mandatory the enrichment of all family white flour, as well as white bread, sold commercially in those areas.

American homemakers, too, favor foods they know to be enriched—a fact demonstrated by surveys. They look for these words on package labels: "Enriched with vitamins and iron for better nutrition."

What Is Enrichment?

It's an axiom in the milling industry that consumers want beautifully fine, white flour. When wheat is milled and processed to get the white flour which the public demands, vitamin and mineral values are unavoidably lost.

Enrichment restores to white flour the following important vitamin and mineral factors: thiamine, riboflavin, niacin and iron. Calcium also may be added as an optional ingredient. The process is simple and inexpensive. A mixture of the vitamins and iron is fed into the flour stream during processing. This insures that the enriching ingredients are spread evenly throughout the flour.

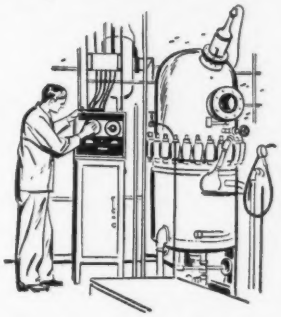
The U. S. Food and Drug Administration has established standards which white flour must meet to be properly labeled enriched. The requirements, in milligrams per pound, are:

	Min.	*Max.*
Thiamine (vitamin B_1)	2.0	2.5
Riboflavin (vitamin B_2)	1.2	1.5
Niacin (another "B" vitamin)	16.0	20.0
Iron	13.0	16.5

(In Canada, too, the same standards have been set for enriched white flour through the amendment of the Food and Drugs Act.)

Vitamins Are Made

The science of chemistry is so advanced these days that many of Nature's complex substances can be "duplicated" in the laboratory. This has happened with many vitamins. First, the chemical composition is learned. Second, the pure substance is isolated. Third, a "duplicate" is made by synthesis. And fourth, the laboratory techniques are extended to large scale operation.



The manufactured "duplicate" is identical chemically and in biological activity with Nature's own product. A vitamin is still a vitamin regardless of its source. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.

The Hoffmann-La Roche people make top quality vitamins actually by the tons. To do this they use amazingly complex processes with scientific production controls and the latest equipment which fill buildings each a city block square and many stories high.

Reprints of this article, and all others in this series are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West; Montreal, Quebec.

The watermills are gone. Today's needs require today's methods. How sensible it is that millers across the nation restore health-giving vitamins and minerals through enrichment.

*Webster's Merriam Collegiate Dictionary includes this definition of "enrich": "to improve (a food) in nutritive value by addition in processing of vitamins and minerals".

IMPORTANT NEWS

For the makers and users of Northwestern Spring Flours and Canadian Flours, for all research chemists in flour mills and large bakeries, and for all research engineers engaged in developing better mixing equipment.

ANNOUNCING...

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CEREAL SCIENCE today

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COVER: The flour mill of Moinho Salvador at Salvador (Bahia), Brazil. The mill was put into operation in late 1955. Design, construction, and equipment by MIAG of Braunschweig, Germany.

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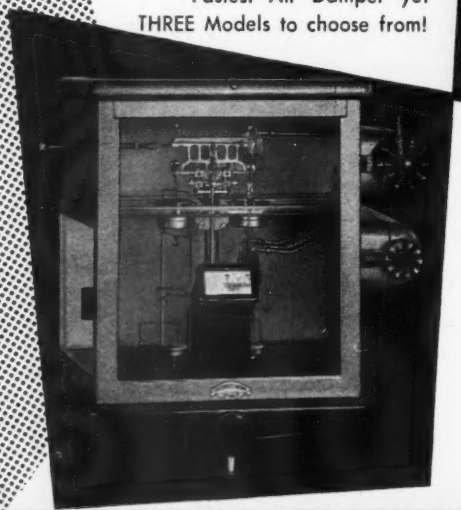

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Editorial

SCIENTIFIC GROUPS TEND to operate according to certain dogmas. Starting with assumptions believed basic, experiments are designed and knowledge built. From these come the advances that we call progress.

Periodically, it is worthwhile to examine our assumptions asking if we still hold these beliefs as truths. Very often such an examination will raise doubts and lead to entirely new sets of thoughts.

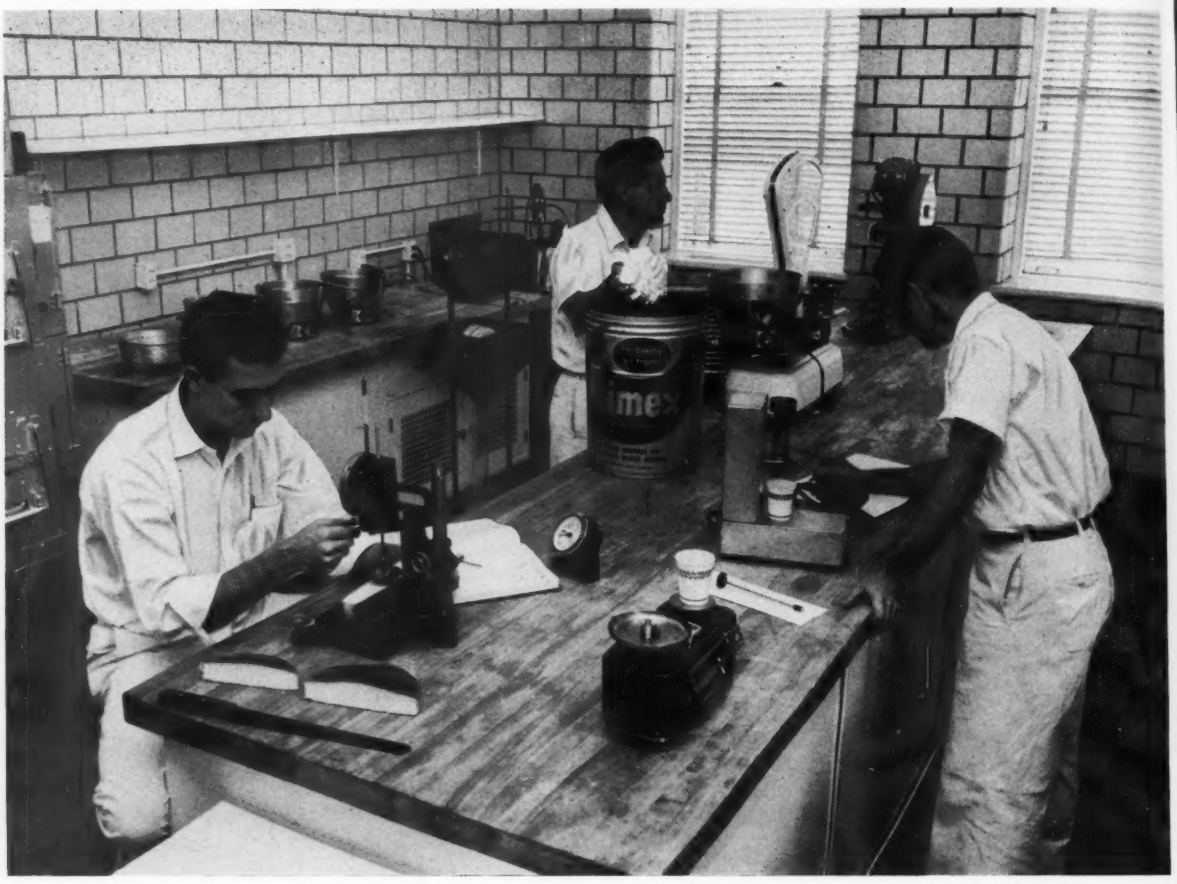
As Cereal Chemists, our tendency is to approach all cereal problems from a chemist's point of view. Perhaps this is not entirely correct. When one thinks of the processes by which we mill our cereal grains and the processes used to prepare these cereal products as foods, it is striking that these operations are not for the most part chemical but rather physical in nature. Perhaps to understand cereal problems, we should be attacking them as physical rather than chemical riddles.

Such a thought is in line with modern scientific accomplishments. The barriers between chemistry and physics are rapidly falling, and today one is hard put to decide where chemistry stops and physics begins. However, the method of approaching problems by the physicist or the chemist is somewhat different and each make their specific contribution.

When I think of our cereal problems as physical phenomena, it seems to me that new vistas are opened. It appears that the solution to some vexing mysteries which have been with us for a long time are close at hand. This can lead not only to the advancement of cereal science but also to the general advancement of the cereal industries. It presents a challenge to those of us who are already working in cereal research and a tremendous opportunity to the young men who are just entering the profession.

ROBERT A. LARSEN

A corner of one of the famous Procter & Gamble laboratories at Ivorydale, Ohio. At P & G, product improvement goes hand in hand with the developments of science.



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OVER FIFTY YEARS OF RESEARCH IN FATS AND OILS

FROM ORCHIDS TO Vanilla

THE VANILLA BEAN is a small item in the food industry, volume-wise; yet it does more to make foods palatable than any other single ingredient.

Vanilla beans are the fruit of a lemon-yellow tropical orchid. The only means of *natural* pollination is a tiny bee which exists only in the vanilla district of Mexico. However, a Belgian scientist discovered a means of artificial pollination, so the orchid can also be grown in other parts of the world.

After scientists discovered a means of artificial pollination, the vanilla orchid was introduced to Madagascar where most of the world's vanilla beans are grown. Nearly all the rest is grown in Mexico. But it remained impossible to bring the vanilla orchid to fruit outside of its native Mexico for 300 years after its discovery by Cortez.

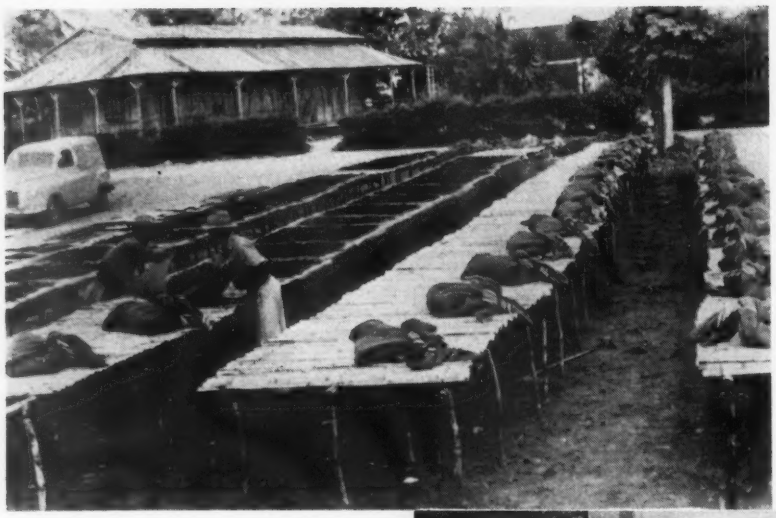
When harvested, the vanilla bean is green, shaped something like a long, slim banana, and has little or no flavor. Flavor must be developed by a long, tedious curing process which takes as long as six months. First, the beans are dried in the sun and then stored inside dark sheds. They shrink to the size of a pencil and turn a deep brown color. This is the form in which consumers find them in specialty food shops and delicatessens.

By far the commonest form of real vanilla in America is pure vanilla extract. This pure extract is a simple extraction of vanilla flavor suspended in alcohol. The alcohol keeps the extraction soluble and easier to use.

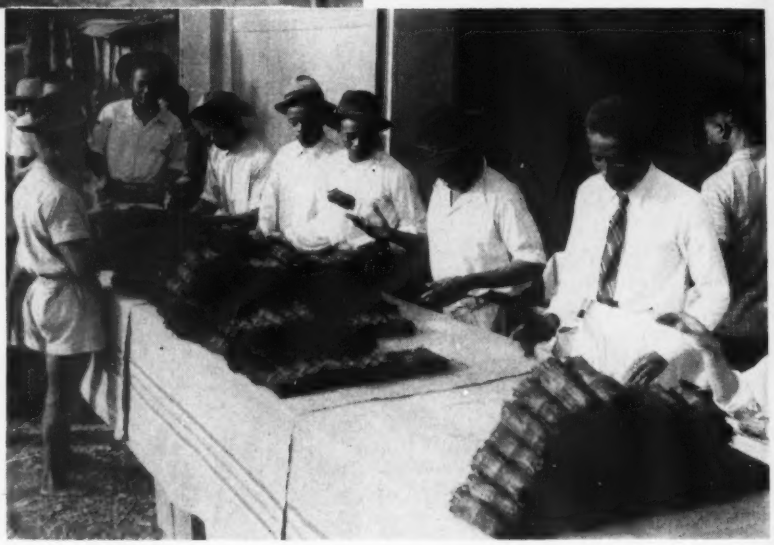
There are other means of utilizing the vanilla flavor, though. A favorite gourmet technique is storing the bean in a canister of sugar until the sugar becomes vanilla flavored. Some gourmets, and homemakers and chefs, chop up the bean and steep a piece in hot milk. The beans are also used by some ice cream manufacturers whose products can be recognized by the tiny dark specks of the finely chopped bean.

The lemon-yellow orchid in bloom. It lives but a few hours before withering on the vine. If it is pollinated, a fruit (the vanilla bean) forms eventually and from this we get vanilla.

Vanilla beans being brought to market in Madagascar. At time of harvesting the beans are green and shaped something like slim bananas.



Spreading vanilla beans out to dry in curing area in Madagascar. Beans are dried in the sun and then stored inside large sheds for as long as six months to develop the vanilla flavor.



Cured vanilla beans being prepared for shipment in Madagascar. Beans are always tied in carefully arranged, compact bundles, a tradition in the trade. Bundles, in turn, will be packed in wax paper lined tin boxes for trip to U.S.

Uses for the Vanilla Bean

However, the original use for the vanilla flavor was in a combination of vanilla and chocolate in a favorite Aztec Indian beverage called "Xocolatl." The Spanish conqueror, Cortez, discovered vanilla while dining at the court of the Aztec emperor, Montezuma.

Although vanilla is popular and useful by itself nowadays, the French still use it in combinations. They fancy it with fruit — fruit preserves, stewed fruit and compotes, and fruit pies and pastries. They find that coffee, butterscotch and caramel are also improved by vanilla. It blends and mellows the other flavors, never overshadowing them, seldom substituting its own flavor.

Out of this French way with vanilla has come a new use for vanilla flavor. The question occurred, "If vanilla will improve and enhance the natural sweetness of fresh fruit, why wouldn't it be possible to make fruit desserts that require less than the normal addition of sugar?" Accordingly, a way was found to utilize vanilla in making satisfyingly sweet fruit desserts with much lower calorie counts.

Vanilla is by far the flavoring most widely used in America. Half of all the ice cream consumed in America each year is vanilla. (In 1955 Americans bought more than 400 million gallons of vanilla ice cream.)

But yet, so unique is vanilla flavoring that its chemical constituents are still unknown to the modern chemical world. Recently, the Flavoring Extract Manufacturers Association and the Vanilla Bean Association of America launched a broad research program entirely aimed at solving the vanilla riddle. Perhaps within the next year or two we will learn WHY the vanilla bean improves or enhances flavor, or imparts a distinctively satisfying flavor of its own to more food than any other flavoring used by the food industry.

COMING NEXT MONTH

Commercial Research by K. L. Thomas and W. E. Anklam, General Mills

A Gamma Irradiation Facility by L. E. Brownell, University of Michigan

Designing Feed Supplements by J. F. Mahoney and W. L. Benson, Merck & Co.

AN AID TO THE EXECUTIVE

Operations Research

By Leon D. Findley *

AN EXECUTIVE'S JOB today is tougher than ever. He has more decisions to make, less time in which to make them, and more dollars and people dependent on the results. It is axiomatic that his decisions will be made more accurately and rapidly if all the important facts are available.

Many decisions involve such subjective factors as people and their emotions. These decisions are an important part of the picture, and their effectiveness depends largely on the judgment, intuition, foresight, and tact of the executive. On the other hand, a sufficient amount of statistical and numerical data will, in many instances, overcome the influence of these intangible factors and make the decision a matter of executive authority.

It is between these two areas, however, that the majority of the decisions lie which face the busy executive. To aid him, a new management advisory service called Operations Research has recently been developed.

As its name implies, the broad scope of this new service is research on operations. More specifically, it is the scientific study and analysis of business problems. Its aim is to maximize the effectiveness of a company's over-all operation. It can be said that Operations Research takes up where market research, industrial engineering, statistics, accounting, production control, and inventory control leave off. It draws upon information from all these fields, calls upon the services of company specialists, and at the same time sublimates the objectives of subgroups to the over-all objective of the company.

It must be emphasized that this new science is to function as an advisory aid to the executive. Successful usage will eliminate much of the guesswork from his decision-making activities, but at no time should it serve as a substitute.

Tools and Techniques

Operations Research is an outgrowth of the efforts of scientists to apply scientific methods of analysis to nonscientific problems. As a result, the operations researcher draws heavily upon the methods of the basic sciences. His chief tools are mathematics, the experimental model, observed data, and objectivity. His basic assumption is that all effects have corresponding causes. His method of analysis is to reduce data to workable components, and to devise an experimental model to aid in his search for the fundamental mechanism of the operation.

Executives, these days, are using Operations Research to solve all sorts of problems. Waiting lines at tool cribs and truck-loading docks have been reduced; optimum balances between inventory levels, production schedules, and customer service have been determined; and production costs have been reduced in the face of fluctuating demand, through optimum scheduling. Successful analyses have increased yields and decreased wastes in chemical processes. All in all, the results of this new approach to business problems have been amazingly productive and extremely gratifying to both executives and operations researchers.

The newness of this discipline and the complexity of over-all business problems have undesirably restricted the scope of many applications. Limitations have been due largely to in-

The author standing beside a magnetic tape storage unit, which is part of a digital computer system used by the Midwest Research Institute. The main computer is in the background.

*Midwest Research Institute, Kansas City, Missouri.

ability of presently available techniques to cope with the task, and not to fundamental concepts of the scientific approach. In many cases, results of an analysis have corresponded to the obvious way of handling the problem and have seemed, at first thought, to be of minor importance. However, the rigidity, thoroughness, and logical basis of the approach establishes for the executive that this "obvious" method is the best. This, in itself, is of great aid to him—no longer need he consider the advisability of investigating alternate solutions.

Successful operations-research studies on problems in railroad operations, aircraft manufacturing, merchandising, mining, highway traffic and road design, and chemical processes in the petroleum industry have been reported in the literature. However, little, if anything, has been said of activities in the food industry. It is the purpose here to describe a few techniques of the field in the light of their possible application by this member of American industry.

A Food Industry Problem

One of the more useful mathematical tools used by the operations research analyst is that of linear programming. By application of this mathematical technique, the best of many possible solutions can be selected for problems expressed in linear terms. One specific form of problem that lends itself to solution by this approach is the blending or mix problem, which often takes the following form. A group of ingredients are to be combined to form an end product or products. Certain measurable quality or quantity values are given for each ingredient, and the corresponding value for the end product is a linear combination of the values. Also, certain minimum or maximum values are prescribed for the same qualities or quantities of the combination. The cost of each ingredient is known, and a desired or feasible sale price is assumed for the end product. It is desired to determine a combination of these ingredients which will meet the quantity and/or quality restrictions of the end product and simultaneously to maximize the profit.

To illustrate, let's assume that it is desired to produce a dog food which can be sold at 40 cents per pound. For dietary reasons, the dog food must meet these requirements: weight of the protein and carbohydrates must each constitute more than 10% of the total weight, and moisture is to constitute more than 70% of the total weight.

Table I lists the ingredients available for use and their characteristcs. Indicating 1000 pounds as the available amount for each of the ingredients in Table I is equivalent to saying that they are equally available. Further, it is specified that no penalty is attached for not using all of any ingredient.

The quantity restrictions can be expressed as: $A_M \leq 1000$, $B_M \leq 1000$, $C_M \leq 1000$, and $D_M \leq 1000$.

$$A_M + B_M + C_M + D_M \leq 4000$$

The quality restrictions can be expressed:

$$75\,A_M + 10\,B_M + 100\,C_M + 5\,D_M \geq 70(M - X_M)$$

$$20\,A_M + 8\,B_M + 35\,D_M \geq 10\,(M - X_M)$$

$$A_M + 80\,B_M + 50\,D_M \geq 10\,(M - X_M)$$

which can in turn be expressed as:

Table I. Characteristics of Available Ingredients (Available amount of each, 1000 lbs.)

Ingredient	*Moisture* % by wt.	*Protein* % by wt.	*Carbohydrate* % by wt.	*Cost* cents/lb.
Horsemeat	75	20	1	20
Barley (pearled)	10	8	80	5
Water	100	0	0	0
Nonfat dry milk	5	35	50	15

The problem, of course, is one of moderate complexity; a suitable solution could be obtained through a trial-and-error procedure. With four available ingredients and only three control quality values, however, the problem is complex enough to illustrate the usefulness of a linear programming approach.

The problem, then, is to determine how much of each of the ingredients is needed to provide a dog food which will meet the requirements and simultaneously maximize profits.

For ease of presentation, the following symbols are defined:

A, B, C, and D equal the amount (1000 lbs. each) of available horsemeat, barley, water, and nonfat dry milk, respectively.

A_M, B_M, C_M, and D_M equal the amount of A, B, C, and D, respectively, used to produce the dog food.

X_A, X_B, X_C, and X_D equal the amount of A, B, C, and D, respectively, *not* used to produce dog food.

X_M = amount of available ingredients not used $= \sum_{i=A}^{D} X_i$.

X_P, X_Q, and X_R equal amount of moisture, protein, and carbohydrates, respectively, in unused ingredients.

$$M = A_M + B_M + C_M + D_M + X_M = A + B + C + D.$$

The quantities designated by X values are referred to as "slack factors" and are introduced to eliminate the inequalities.

$$5\,A_M - 60\,B_M + 40\,C_M - 65\,D_M \geq 0$$

$$10\,A_M - 2\,B_M - 10\,C_M + 25\,D_M \geq 0$$

$$-9\,A_M + 70\,B_M - 10\,C_M + 40\,D_M \geq 0$$

The requirement that the profit be maximized can be expressed mathematically by

$$\begin{array}{l} 40\,A_M + 40\,B_M + 40\,C_M + 40\,D_M = \text{selling price} \\ 20\,A_M + 5\,B_M \qquad\qquad + 15\,D_M = \text{cost} \\ \hline 20\,A_M + 35\,B_M + 40\,C_M + 25\,D_M = \text{profit} \end{array}$$

The problem, therefore, reduces to the following mathematical form, when the various slack factors are introduced:

$$A_M + X_A = 1000$$

$$B_M + X_B = 1000$$

$$C_M + X_C = 1000$$

$$D_M + X_D = 1000$$

$$A_M + B_M + C_M + D_M + X_M = 4000$$

$$5\,A_M - 60\,B_M + 30\,C_M - 65\,D_M - X_P = 0$$

$$10\,A_M - 2\,B_M - 10\,C_M + 25\,D_M - X_Q = 0$$

$$-9\,A_M + 70\,B_M - 10\,C_M + 40\,D_M - X_R = 0$$

To maximize:

$$P = 20\,A_M + 35\,B_M + 40\,C_M + 25\,D_M$$

This type of problem cannot be solved as a set of simultaneous linear equations, as we have eight equations in twelve unknowns. It is possible to obtain an answer by the trial-and-error method, but this approach is

time-consuming if there is a significant number of unknowns, and, as can be seen, there are twelve unknowns for this simple problem. For larger problems the number of unknowns will increase rapidly; in another dietary problem which has been investigated, there were approximately 50 unknowns. For such large problems, any method other than a systematic mathematical approach would be nearly impossible, and the use of an automatic digital computer is advisable.

Linear Programming Analysis

A trial-and-error approach will provide a solution to the above system of linear equations, although there is no assurance that the solution obtained is an optimum one. However, through the use of linear programming, the set of equations can be systematically solved, and an optimum solution obtained. The mechanics of solution will not be discussed; they can be obtained by reference to published literature (1).

A straightforward linear programming analysis for the above equations can be accomplished in a few hours on a desk calculator, and will show that the optimum combination is

$$A_M = 1000 \text{ lbs.}$$
$$B_M = 536.8 \text{ lbs.}$$
$$C_M = 1000 \text{ lbs.}$$
$$D_M = 42.9 \text{ lbs.}$$

There are other combinations which will satisfy the quality and quantity restrictions. However, no other combination will simultaneously satisfy the restrictions and provide any greater profit than the above. This assurance of obtaining an optimum solution is the outstanding characteristic of a linear programming approach.

A Transportation Problem

Another useful application of the linear programming technique is to the so-called "transportation" problem. Here the problem is often that of allocating shipments so as to minimize transportation costs.

For an illustration, assume that a company has available 100 carloads of wheat stored in Minneapolis warehouses, 50 in Chicago, and 50 in Kansas City. Assume for convenience that a "carload" is equivalent to 2,000 bushels. With this supply available, the company must satisfy demands for 30 carloads in Minneapolis, 30 in Chicago, 25 in Kansas City, 45 in St. Louis, 35 in Peoria, and 30 in Des Moines.

The dispatcher's problem is to determine which warehouse should supply each demand, and to choose a distribution with minimum transportation cost.

For simplicity, assume that the capital value of the wheat is the same in all warehouses, and that transportation charges for moving 2,000-bushel carloads are as shown in Table II. Again, a systematic and straightforward mathematical procedure can be used to determine a distribution of shipments which will minimize transportation costs. In this particular instance, there are two distributions with equal transportation costs, and either may be used.

Table II. Transportation Charges for 2000-Bushel Carloads

From:	*To Minneapolis*	*To Chicago*	*To Kansas City*	*To St. Louis*	*To Peoria*	*To Des Moines*
Minneapolis		$285	$420	$550	$385	$220
Chicago	$285	....	$348	$290	$100	$250
Kansas City	$420	$348	....	$270	$250	$200

Table III. Solution I for the Distribution of Warehouse Supply to Meet a Given Demand (Carload Units)

From:	*To Minneapolis*	*To Chicago*	*To Kansas City*	*To St. Louis*	*To Peoria*	*To Des Moines*	*Total Supply*
Minneapolis	30			20	15	30	100[a]
Chicago		30			20		50
Kansas City			25	25			50
Total demand	30	30	25	45	35	30	200 / 195

[a] Supply of 100; 95 used to satisfy demands.

Table IV. Solution II for the Distribution of Warehouse Supply to Meet a Given Demand (Carload Units)

From:	*To Minneapolis*	*To Chicago*	*To Kansas City*	*To St. Louis*	*To Peoria*	*To Des Moines*	*Total Supply*
Minneapolis	30	15		20		30	100[a]
Chicago		15			35		50
Kansas City			25	25			50
Total demand	30	30	25	45	35	30	200 / 195

[a] Supply of 100; 95 used to satisfy demands.

The two solutions are presented in Tables III and IV, and neither is readily apparent from a cursory examination of input data. For instance, note that in both solutions the optimum shipping distribution requires that shipments be made from Minneapolis to St. Louis, the most expensive haul listed in the transportation charges of Table II. Also, in one solution it is cheaper to ship wheat into Chicago to provide for part of the demand than to use the warehouse to supply all the local demand. For either solution the cost of moving 195 boxcars is the same, *and there is no better distribution.*

Queueing or Waiting Line Theory

Another useful mathematical tool used by the operations research analyst is that of the queueing or waiting-line theory, a specific field of statistics. In general, this tool has been used for analyses where it was desired to determine 1) the amount of equipment or personnel needed to provide a chosen level of service, or 2) the most economical balance between the cost of providing rapid service and the cost of time lost in waiting for service.

The major use of the waiting-line or queueing theory in this country has been in the operations of the telephone companies. In practically all instances, decisions by management concerning the amount of switching equipment needed at central offices are based upon waiting-line or queueing studies. The success of the application is evidenced by the relatively few times that any of us get a "busy" signal because of equipment overloads.

Queueing analysis can be applied to many forms of service and business operations where the servicing times vary randomly, and the times at which service must be provided occur randomly. Thus, such analyses can be applied to the study of waiting lines at service counters, the unloading of trucks at docks, the amount of space required for parking areas, the size of

a railroad switching yard, and numerous other industrial applications.

One useful example of the successful application of queueing has been exploited in this country and in Sweden; namely, that of determining the most economical number of servicemen needed to maintain a given number of automatic machines in operation. In this analysis, it is usually assumed that the machines break down in an independent fashion; that is, each machine failure is independent of the failure of any other machine in the system. It is further assumed that the time needed to repair the machine varies in a random manner. Successful analyses have provided values for the average amount of lost machine time, and the average amount of unused serviceman time for different-sized maintenance staffs. The relative cost of these two time values, applied to the results of the queueing analysis, will determine the most economical size of maintenance staff.

Queueing Analysis for Trucking Operations

Another form of queueing analysis, which has been described by members of the staff of the British Overseas Airways Corporation (2), would be of interest to any organization operating a fleet of trucks. It was desired, in the above instance, to determine the optimum number of spare engines needed to maintain constant operation of a fleet of aircraft. The similarity between this reported study and one which could be conducted for those operating a fleet of delivery trucks is readily apparent.

For this analysis it was assumed, first, that unserviceable items (engines) were generated randomly by failures and routine equipment inspections, and further, that the amount of time needed to repair an engine varied randomly. A flow diagram of the problem is given.

As is shown, the unserviceable engine is removed from the aircraft and sent immediately to a repair shop. At some random time later the repaired item is delivered from the shop to a supply depot. For successful operation of the aircraft fleet, a waiting line of serviceable engines must be present at the supply depot. This is in contrast to the usual form of waiting-line study, where the purpose of the study is to reduce waiting lines to a minimum.

If sufficient spare items are available in the system illustrated in the accompanying chart, the probability is very high that there will always be a serviceable unit available to replace any failure. As the number of spares is decreased, the chance of an operational emergency (when there are no repaired units available to replace the failing item) increases. A decrease in the capital invested in spares, therefore, is offset by an increase in the probability of having an unserviceable airplane.

Satisfactory operation of the aircraft fleet is based largely upon a defined level of service, which constitutes "good" service. If an operational emergency occurs, on the average, only once a year, it might under some circumstances be considered satisfactory operation. Again, it may be the desire of the management to operate the fleet so as to have no more than one operational emergency, on the average, every five years. A straightforward and practical application of waiting-line theory to the problem can provide management with an economic evaluation for each chosen level of service.

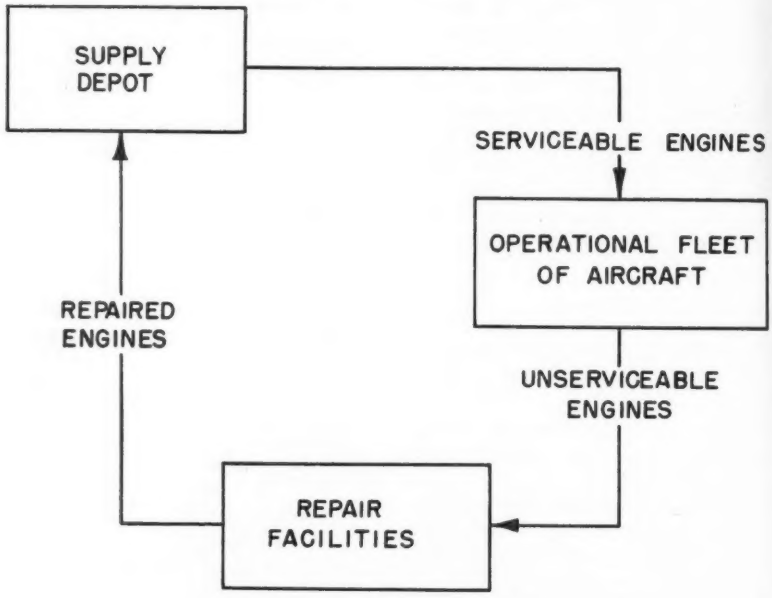
In addition to the number of spare engines in the system, variations in the speed of repairing engines will affect the level of service. Or, conversely, for a prescribed level of service, the speed of repair will affect the number of spares needed. This factor, too, can be evaluated by proper analysis.

Production Control

Many operations-research studies require the combined use of a number of mathematical tools. One example is the study of production control. Included are the techniques of allocation, where work is to be divided among several machines; waiting-line theory, where studies must be made of the waiting lines that occur in an efficient production line; and statistical theory, which is included in the basic preparation and analyses of sales forecast figures.

As in nearly all operations-research studies, a mathematical model of the production line is first devised. This model relates, insofar as is possible, the many supply-and-demand characteristics of the pertinent system. It may include any or all of the above mathematical techniques. One appropriate approach that has been successfully applied is to consider the control of a production line as analogous to a servomechanism problem. The analogy is readily apparent. Both can be considered as methods of controlling the output of a system through some relationship between input and output.

In a servomechanism the control value is often the difference between output displacement of a motor rotor, planing table, etc., and some input reference value. In a production con-



Engine rapair cycle for fleet operation.

trol system, the output of the production shop is usually related to input data (sales forecasts, actual sales, desired buildup of inventory, inventory level) to control production activities.

The tie-in of production control problems with inventory problems, another field of operations research activity, is obvious. In most cases, the two are closely connected at the management level. Decisions in inventory level will radically affect the closeness of production control. The reliability and accuracy of production control will have a decided effect upon the level of inventory to be maintained. It is in this role of studying the interrelations between various functions of a business that the operations-research approach is most effective.

Scope and Future

From these examples, it is apparent that the scope of Operations Research is far-reaching, and that its application utilizes various form of higher mathematics. Thus, the effectiveness of this new service to an executive is highly dependent upon the skill and training of the analyst.

The qualities required of a successful operations-research analyst — ingenuity, initiative, scientific training, ability to work with others, and organizational ability — are employee characteristics desired by almost all employers in other fields of science. Analysts trained in Operations Research are few in number; the rapid growth of the field is creating a shortage in suited personnel.

To add this advisory service to his office, the executive may act in various ways. He may hire trained analysts to be members of his staff; he may train qualified employees of his firm at schools offering courses in Operations Research; or he may make use of consultant services. A number of firms embarking on this new endeavor are pursuing the latter course. A trial use of this new discipline can be obtained at less capital risk.

Independent scientific research organizations have been quick to add this new science to their fields of research service. Scientific talents are available in these groups, and the "team" concept that they generally employ to solve problems is fundamental in Operations Research.

This method of analyzing business activities is not a panacea for all the executive's problems. It is, however, the biggest step made in the past decade towards easing his ever-increasing decision-making burden. In this age of rapid progress in automation, increasing diversification in business activities, and shortage of skilled management personnel, Operations Research should be seriously considered and thoroughly investigated by management. After all, the overworked and overloaded executive's health that you preserve may be your own!

The author wishes to acknowledge the invaluable aid of Dr. C. N. Kimball and Mr. Aaron Glickstein in the preparation of this publication.

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People, Products, Patter

. . . People

Edward E. Anderson has joined the staff of the flavor laboratory of Arthur D. Little, Inc., Cambridge, Mass. He was formerly associate professor of food technology at the University of Massachusetts.

• • •

L. E. Doxsie has been appointed assistant manager of the A. E. Staley Mfg. Co. corn division.

• • •

W. L. Faith has been appointed managing director of the Air Pollution Foundation. He has served as chief engineer of the foundation since its organization, and succeeds **Lauren B. Hitchcock**, who has returned to consulting practice. Mr. Faith was formerly director of engineering at Corn Products Refining Company's chemical division.

Joseph A. LeClerc, 83, internationally known agricultural scientist and well known in baking circles, died November 16, 1956. He had worked with the U. S. government for over 40 years until his retirement in 1943. Dr. LeClerc was a member of the American Association of Cereal Chemists and attended many of the Association's early meetings, when its policies were being formulated.

Clifford J. Robertson, an active member of the Ohio Valley Chapter of the Institute of Food Technologists, has been transferred from the Product Research Department of the Procter and Gamble Company in Cincinnati to the firm's sales office in New York City. There he will serve as Eastern Regional technical sales representative in the Bulk Shortening Sales Department.

• • •

Katharine A. Schweizer is now associated with E. H. Sargent and Company, Chicago, and also assists her father, **Fred G. Schweizer**, food processing consultant.

• • •

Homer Eaton Stavely has been appointed director of biochemical research for Mead Johnson and Co., Evansville, Ind.

Leo Wallerstein, founder and board chairman of Wallerstein Co., Inc., died November 6, 1956. Mr. Wallerstein was well known for his many contributions in the application of enzymes to a wide variety of industrial uses.

. . . Patter

The fifth annual meeting of the American Association of Feed Microscopists will be held April 8, 9 and 10 at the Phoenix Hotel, Lexington, Kentucky. Fred Randall, Chairman of the Education and Publicity Committee, points out that it is important that hotel reservations be made early.

• • •

The 1957 Congress of the European Brewery Convention will be held from June 2 to 6 in Copenhagen, Denmark. Members and friends of the American Association of Brewing Chemists who wish to attend the Copenhagen meeting may register with Kurt Becker, 4055 West Peterson Avenue, Chicago 30, Illinois.

• • •

Doty Laboratories moved on December 15, 1956, to their permanent quarters at 1435 Clay Street, North Kansas City 16, Missouri. The new facilities are larger and more complete than former facilities. The laboratories will include a special department for vitamin assay and enlarged facilities for experimental milling, baking, and feed analyses. James M. Doty, Director, invites everyone to visit the new quarters.

• • •

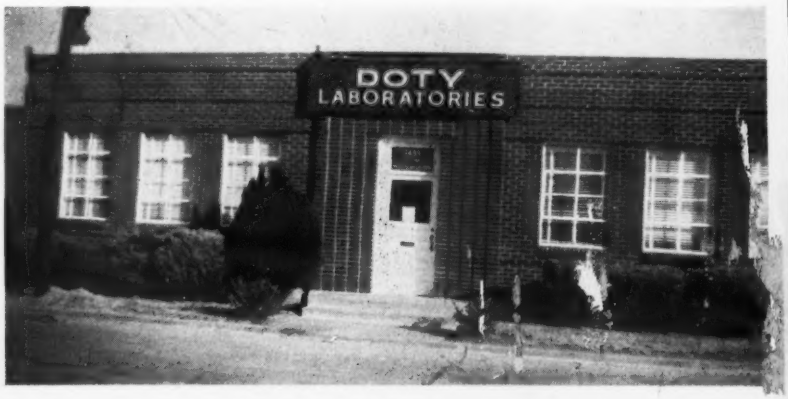
Monsanto Chemical Company will establish an advanced management course at Excelsior Springs, Missouri, early this year. In announcing the plan, Francis J. Curtis, vice president for personnel, said the main purpose of the course is to provide participants with a broader view of business operations than they normally get in carrying out their particular duties with Monsanto. Furthermore, in establishing its own course, Monsanto expects to fit the curriculum to its distinct needs better than could be done if the course was set up by an educational institution.

Faculty members of universities throughout the country will give lectures during the first of two sessions, each to be three weeks long. In addition, special lectures will be given by guest speakers from Monsanto and business, industry, and consulting groups outside the company during both sessions.

• • •

A new booklet published by the Wheat Flour Institute, Chicago, entitled "From Wheat to Flour," tells the story of wheat from its beginning as the seed of a wild grass, through modern flour milling. It is readable in style, printed in two colors and large type, designed to serve as a basic reference for teachers and students in upper elementary grades, high schools, and colleges.

Student copies are 25 cents each. Single copies are provided free to professional persons. Milling companies and related industries may order copies in quantity at reduced prices, furnished on request. Dept. P-1, Wheat Flour Institute, 309 W. Jackson Blvd., Chicago 6, Ill.



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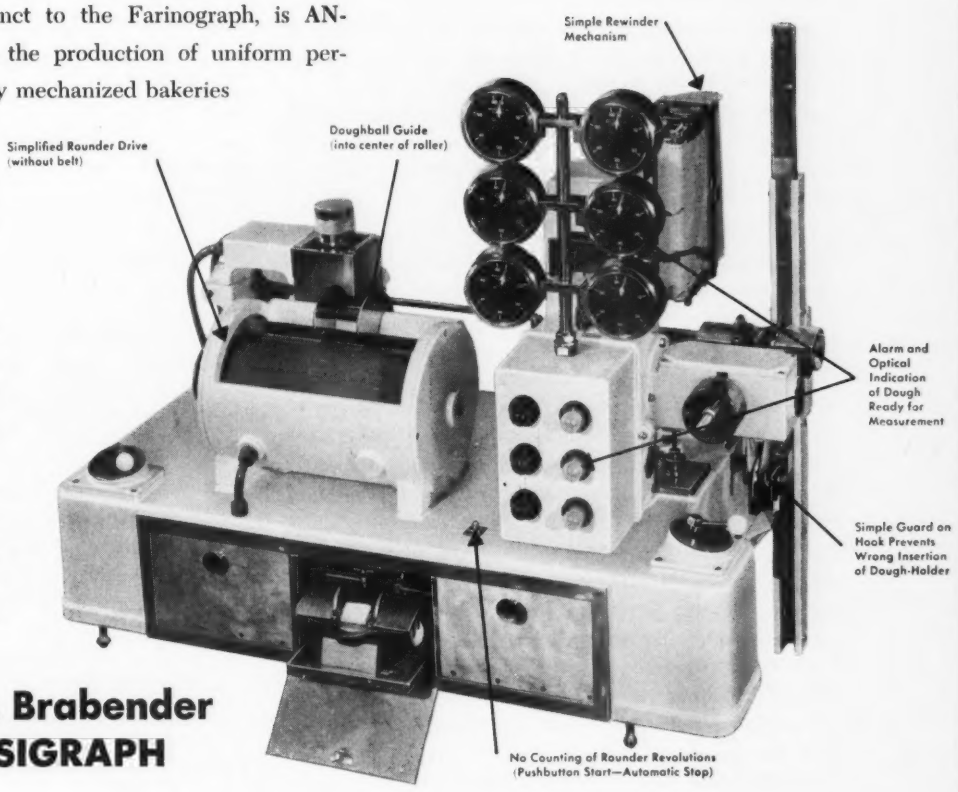
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THE EFFECT OF WHEAT BUGS ON THE MALTOSE CONTENT OF WHEAT[1]

PEKKA NUORTEVA, Zoological Laboratory of the University of Helsinki, Finland

MALTOSE VALUE HAS been used to estimate the extent to which wheat has germinated as a result of unfavorable environmental conditions at the time of harvesting. However, this criterion may give an erroneous indication, since the maltose content may be greatly influenced by some insect species, collectively called wheat bugs, which in their feeding act secrete a salivary fluid into the ripening kernels.

Kernels with typical symptoms of bug injury (small, dark spots with a surrounding pale area) occur frequently in wheat fields in Asia, Europe, North Africa, and North America (6, 7,). Most commonly only 0.5 to 5.0% of the kernels are injured, but percentages as high as 87 have been reported (4), depending upon the population density of the insects.

Information on the occurrence of amylases in the salivary glands of wheat-injuring bugs has been reported (3, 5) from the following species: *Lygus rugulipennis* Popp. (nymphs, adults), *Adelphocoris lineolatus* Goeze (adults), *Capsus ater* L. (adults), *Miris dolabratus* L. (adults), *Stenodema calcaratum* Fall. (adults), *Dolycoris baccarum* L. (adults), *Eurygaster integripes* Put. (nymphs, adults), and *Aelia acuminata* L. (adults). The results of these determinations show that amylases exist in the salivary glands of all these species, as is also true of most phytophagous bugs (1).

The degradation of wheat quality by the salivary proteases of certain wheat bugs is well known and the literature on this subject has recently been reviewed (5). Very little attention has, however, been directed to the amylolytic effects of the saliva in wheat kernels. Kretovich (2) has observed that the amylase activity is increased in wheat kernels injured by *Eurygaster integripes* Put., and the data of Nuorteva and Veijola (6), reproduced in Table I, illustrate that wheat kernels injured heavily by the insect *Lygus rugulipennis* Popp. have a higher maltose content than that of less-injured kernels.

TABLE I

EFFECT OF INJURY BY LYGIS RUGULIPENNIS ON THE MALTOSE CONTENT OF WHEAT KERNELS

WHEAT VARIETY	INJURED KERNELS	MALTOSE CONTENT
	%	%
Diamant	12.0	4.0
	0.4	3.2
Kärni	16.2	4.0
	2.6	4.3
	0.7	2.7
Rival	18.3	4.6
	7.0	3.9
Ta a 4656	21.2	3.6
	0.6	3.0
Terä	15.5	5.1
	5.5	4.1
	0.2	3.5
Weib. 4808	15.1	5.1
	3.2	4.1

Since bugs which injure wheat kernels occur very commonly and deposit salivary secretions possessing amylase activity into the kernels, the maltose content of wheat or of the flour obtained from it may not be a reliable measure of the extent to which the kernels have germinated.

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THE ZELENY SEDIMENTATION TEST APPLIED TO GERMAN WHEATS[2]

W. R. SCHAEFER, Federal Research Institute of Cereal Industry, Detmold, Lippe, Germany

THE SEARCH FOR a simple universal method for a comprehensive determination and expression of the "quality" of a particular lot of wheat has failed to attain the desired goal. This has occurred in spite of the numerous efforts of outstanding scientists throughout the world. The reasons for this failure include the ambiguity of the concept of "quality", the variety of the requirements imposed upon the several types of wheat, and the inherent heterogeneity of larger lots of grain.

Each procedure which would appear to approach the above objective has been closely studied and tested. Attempts also have been made to determine the limits of validity of the method in order to establish its practical

[1] Manuscript received May 19, 1955.

[2] Manuscript received for publication June 29, 1956. Translated with the assistance of Henry Baehr of Foreign Agricultural Service.

usefulness. Such a review and study of Zeleny's method has taken place since its presentation to cereal researchers in the scientific literature of the United States. The European research workers, Bennett and Hulse (1), Rotsch (4), and Fuchs (2), have made it the object of critical studies. Fuchs concluded that the utilization of the sedimentation test results only in the rough classification "poor," "medium," and "good," with a minimum sedimentation value of 35 for the "good" grouping. In order to differentiate quality in the range below 35, a further test method for which the wet gluten test is appropriate, is unavoidable. From the sedimentation value and the wet gluten content it is possible to predict the swelling-number, and the farinogram and extensogram types. The prediction of baking value from the sedimentation number is possible only in a very wide range. Thus, the sedimentation test is suitable for evaluating cracker flours, for guidance in the purchase of wheat, and in plant selection when supplemented with the wet gluten test. These conclusions by Fuchs represent the general opinion of the Zeleny sedimentation test in Europe. Haertlein (3) convincingly demonstrated the usefulness of the method for the classification and evaluation of Argentine wheats.

Two circumstances encouraged research at the Federal Research Institute at Detmold, Lippe. First, the publication in Germany of the detailed procedure by Zeleny (5, 6) offered the possibility of making comparisons with results obtained in other countries. Second, discussions of the method were carried on with Dr. Zeleny during the Third International Bread Congress in Hamburg, and in the course of his subsequent visit to Detmold.

In these conversations the importance of being able to include and express the technological value of wheat in the grain standards was discussed. The procedure chosen to determine such technological value and to express it in a simple term should meet the special requirements of a single country. It also should be capable of describing objectively within reasonable limits the quality of all kinds of wheat from all over the world. The determination of protein content does not suffice, since the quality of gluten may be at least as important as the quantity of protein. Furthermore, gluten quality becomes increasingly important at lower protein levels.

The purposes of the Zeleny Sedimentation test investigations at the Federal Research Institute were:

1. To examine the Zeleny procedure in terms of its general usefulness as a laboratory method;
2. To accumulate data in order to ascertain the possibility of successfully classifying domestic German wheats as has been done by Zeleny for United States wheats;
3. To study the effects of nitrogen fertilizers upon wheat quality, since the use of such fertilizers is increasingly important to European agriculture.

Methods

Production of Flour for the Test. The basic problem in the sedimentation test is the production of suitable flour. Without uniform, or at least comparable, procedures for the production of test flours, any attempt at a broad application of the test can only end in inconclusive results.

Zeleny's method prescribes the use of Tag-Heppenstall rolls. Since the Tag-Heppenstall device is unknown in Europe, it was necessary to devise a different method of milling which would yield flour of comparable characteristics.

The use of the Buhler automatic mill would be a natural choice, but it is expensive and available in only a few laboratories. Its usefulness also is limited when only small samples of wheat are available.

The problem was how to make use of laboratory mills, generally available in German laboratories, to produce flour according to Zeleny's recommendation. These specifications included about 12.5% yield and flour of 0.6% ash. The problem was particularly difficult because the milling method must be applicable not only to soft domestic wheats, but also to harder wheats such as the Manitobas, and domestic Heines Koga II which has comparable hard kernel characteristics.

Only cone-burr mills, or the laboratory experimental mill rolls appeared to be applicable. The cone-burr mill (Miag or Brabender) appeared to be reasonably usable at least for the soft wheats since they yield 20-23% of flour at a wheat moisture content of 14-16%, and with the required low ash content. The ash specification could not be met with harder wheats such as hard winter, however, even when milled at higher moisture levels.

The Miag experimental mill remained. Even this mill could not meet Zeleny's essential requirement of milling at roll speeds of 30 r.p.m. It is relatively easy to obtain a high proportion of flour if wheat is ground at slow roll speeds. At higher speeds a greater quantity of middlings is obtained. Differences in procedure in reducing these middlings to flour by smooth or scratch rolls strongly influence the character of the resulting flour, since the swelling properties of the flour particles are altered to a degree which cannot be controlled.

The data in Table I show that the greater the roll pressure the higher the sedimentation value. Thus, the use of smooth rolls should accordingly be avoided if possible. The following procedure using the Miag experimental mill

TABLE I

INFLUENCE OF FLOUR PREPARATION ON THE SEDIMENTATION VALUE (Heines Koga II)

MANNER OF GRINDING	FLOUR YIELD	ASH CONTENT	SEDIMENTATION VALUE
	%	%	
3 x Corrugated rolls, 0.6 mm spacing 2 x Corrugated rolls, 0.4 mm spacing	10.0	0.79	25.0
3 x Corrugated rolls, 0.6 mm spacing 1 x Smooth rolls, 0.3 mm spacing	10.7	0.69	28.6
3 x Corrugated rolls 2 x Smooth rolls	14.7	0.64	30.7
3 x Corrugated rolls 3 x Smooth rolls	17.8	0.61	32.3

with special rolls for production of the test flours has been found effective:

Roll data	
Diameter	160 mm.
Corrugations per cm.	12
Flute angles	45/75
Spiral	16%
Fast roll	125 r.p.m.
Roll speed ratio	4:5

Procedure for Soft Wheats. The wheat is tempered to 12-14% moisture, ground three times at a roll spacing of 0.6 mm., sifted 1.5 minutes on a 1200 μ wire cloth and 150 μ silk. The throughs of the 1200 μ wire cloth are then ground twice at a roll spacing of 0.2 mm. and sifted on the 150 μ silk. This milling method takes about 12-14 minutes.

Procedure for Hard Wheats. The procedure is the same as for the soft wheats, except that roll spacings of 0.4 mm. and 0.1 mm. are employed. The test results can be perceptibly and even significantly modified if the milling instructions are now followed precisely. To achieve a wider use of the Zeleny test for the evaluation of wheats, the development of an inexpensive, simple laboratory mill is essential. Even the flours from the Buhler automatic mill exhibited appreciably different results, up to 12 units higher for several wheat varieties than with the flours produced by our method.

The Determination of the Sedimentation Value. The actual determination of the sedimentation value does not pose any particular difficulties. To avoid confusion it has been found useful, particularly in series studies, for two workers to do eight analyses simultaneously. The specified time intervals can then be observed exactly. In the absence of a mechanical shaker described by Zeleny, manual shaking can be employed, but the results are about 3-6 units lower. Several examples are shown in Table II.

TABLE II

THE INFLUENCE OF SHAKING ON THE SEDIMENTATION VALUE

KIND OF WHEAT	SEDIMENTATION VALUE	
	Mechanical shaker	Hand shaking
Carstens V	10.4	5.7
Carstens VI	13.5	9.3
Carstens VIII	26.5	23.4
Onoldia	30.6	25.5
Tassilo	33.6	27.3

The reading of the graduates is usually quite easy, and in only a very few samples was the sediment level not sharply defined.

Experimental Results

Reproducibility of Results. The reproducibility of the results is exceptionally good, particularly when one considers the simplicity of the method. Normally about 90% of the values fall within a limit of 1 unit. On the basis of many hundred measurements, it is concluded that duplicates seldom fail to check within 1 unit.

Evaluation of the Test Data. The apparent relationship between sedimentation values and protein content has led to proposing a "specific sedimentation value." This is sedimentation value divided by percentage of protein. It is appropriate since in evaluating two wheats with equal sedimentation numbers one would give the wheat with the lower protein content the higher rating.

The difficulties associated with the production of a uniform test flour also suggest a relation between sedimentation values and the ash content of the flour (see Table I). The suggestion is therefore made that the ash content of the flour be taken into account by multiplying the specific sedimentation value by the ash content and by 100. The reason for this suggestion is that sedimentation values decrease with increasing flour ash content, so better evaluations of wheat should be obtained when sedimentation values are corrected for differences in ash content. Details are given in Table III. The significance of such calculations should not be overestimated, but it may be advantageous in some cases to use this "modified specific sedimentation value."

TABLE III

THE INFLUENCE OF ASH CONTENT ON SEDIMENTATION EVALUATION

KIND OF WHEAT	SEDIMENTATION VALUE	ASH CONTENT OF FLOUR	PROTEIN CONTENT OF FLOUR	SPECIFIC SEDIMENTATION VALUE	MODIFIED SEDIMENTATION VALUE
		%	%		
Heines Peko	13.0	0.43	8.5	1.5	65
Strubes Dickkopf	13.5	0.48	7.3	1.9	91
Carstens VI	13.5	0.44	7.7	1.8	79
Schweigers Taca	29.6	0.59	8.9	3.3	195
Hauters II	30.2	0.45	9.8	3.1	139
Wahrberger Onoldia	30.6	0.50	9.9	3.1	165
Peragis Garant	40.0	0.84	13.1	3.1	260
Janetzkis Probat	42.7	0.79	13.1	3.3	261
NOS Nordgau	42.7	0.52	13.1	3.3	172

The Quality of German Wheat Varieties

It could be predicted from experience that the sedimentation value would be valuable as an additional quality determination for domestic German wheats. The results have confirmed these expectations.

A complete analysis of recent data obtained at the Federal Research Institute will be possible some time later. Meanwhile, the figures already obtained are suitable to demonstrate the use of the Zeleny method to characterize domestic wheat varieties. This is shown by the data in Table IV. The wide range of quality and the obvious possibility that mills would gain by the use of the sedimentation test can be observed from this table. Unfortunately,

TABLE IV

QUALITY OF GERMAN WHEAT VARIETIES

KIND OF WHEAT	SEDIMENTATION VALUE	SPECIFIC SEDIMENTATION VALUE	MODIFIED SEDIMENTATION VALUE	"TESTZAHL"	BREAD LOAF VOLUME
Carstens V	11.4	1.4	52	16	322
Heines VII	18.5	2.3	85	26	312
Strubes Dickkopf	19.4	2.2	84	45	320
Heines Peko	20.8	1.9	70	30	327
Heines IV	21.0	2.2	110	45	387
Carstens VI	22.2	2.4	89	99	420
Carstens VIII	29.8	3.3	129	62	400
v. Rumkers Erli	33.0	2.9	151	173	436
Langs Tassilo	40.2	3.4	126	60	414
NOS Nordgau	43.5	3.4	126	217	514
Peragis Garant	52.5	4.1	218	161	520

the poorer varieties of wheat are usually grown in Germany because they sometimes give a better yield.

The Influence of Higher Levels of Nitrogen Fertilization

The intensive agriculture in Germany explains why the efforts for gaining higher yields and better qualities are increasingly emphasized. The dominating varieties of wheat grown in central Europe are derivatives of the "square head" wheats. Fertilization with one or more applications of nitrogen is widely practiced. Fertilization with nitrogen increases the protein and wet gluten content of these wheats; at the same time the gluten quality and swelling ability may decrease.

TABLE V
THE INFLUENCE OF INCREASING NITROGEN APPLICATION

KIND OF WHEAT		NITROGEN (kg/ha) 0	40	60	80	100
Criewener 192	Protein content %	10.6	12.0	12.0	11.8	12.2
	"Testzahl"	24	28	25	26	30
	Sedimentation value	12.3	11.3	10.8	10.8	11.7
Breustedts Werla	Protein content %	9.3	11.2	11.9	13.8	13.3
	"Testzahl"	76	80	67	73	72
	Sedimentation value	15.7	17.6	18.6	19.6	22.0
Carstens VIII	Protein content %	9.7	10.1	9.7	9.6	9.7
	"Testzahl"	69	70	96	103	90
	Sedimentation value	19.1	21.6	24.0	28.2	27.5
Schweigers Taca	Protein content %	11.6	12.3	13.1	13.9	14.7
	"Testzahl"	50	50	47	38	46
	Sedimentation value	31.4	26.2	26.9	30.0	29.3

The results of the sedimentation test confirmed these general experiences only partly. In no case was there a marked decrease of the sedimentation value with higher amounts of nitrogen. Sometimes the differences were within the limits of error of determination, and in numerous instances an increase of the sedimentation value of 4 to 8 units was observed. Some characteristic results are given in Table V.

Discussion

The application of the Zeleny sedimentation test is associated with certain analytical requirements, among which the possibility of a uniform and comparable production of flour is particularly important. If one follows the procedural details, including the use of a suitable shaking apparatus, the method can be used to determine the commercial value of wheat with sufficient precision for practical purposes in the movement of wheat from the grower to the mill.

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OVERSEAS REPORTS

. . . ENGLAND

In October 1956, representatives of Elliott Brothers Ltd., London, and Thos. Robinson & Son Ltd., Rochdale, met at the Robinson works to discuss the Elliott electrical techniques for the control of food manufacturing processes in the grain and milling industries.

The conference dealt with two aspects of the subject — temperature and weight. The Elliott technique for monitoring grain temperatures is similar to the Zeleny system, well known in North America. It embodies nylon-protected thermocouple cables equipped with high speed potentiometric temperature indicators. It is said to include, among other advantages, an increased number of temperature sensing points and a reduction in cable diameter which reduces downward pull.

The Elliott weight measuring system is comprised of an element in the form of a capsule, called a load cell. In essence, it is a steel billet which is deformed when loaded. Several wire strain gauges, bonded to the billet, are connected in a Wheatstone bridge circuit. (A strain gauge is a loop of wire which increases its electrical resistance when stretched. Within limits, the wire will resume its length and resistance when the stretching force is removed.) A polarizing voltage is applied to the bridge circuit which emits an output signal proportionate in intensity to the load on the billet.

This system uses no moving parts; the measuring capsule is hermetically sealed to protect it from dust; and, naturally, remote recording and control can be readily arranged.

The load cells are self-temperature compensating within the rated range of operating temperatures and are calibrated within an accuracy of $\pm 0.5\%$ of full range at all points from 0–100% of capacity. As for the complete installation, it is claimed that the normal accuracy of 1, 1½, or 2%, depending on the type of electrical system, may be further improved by calibrating the complete installation site.

Participants in the conference also discussed the application of the system to determination of the contents of silos and other containers and of pressures in rolling mills, and the control of blending operations in a feedstuffs plant.

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A.A.C.C. LOCAL SECTIONS

Pioneer Section met on Friday and Saturday, December 7 and 8, in Hotel Allis, Wichita, Kansas. The committees assembled on Friday evening. On Saturday, four speakers appeared before the meeting — Faye Buck, C. R. Harlow, Frank Wischer and J. L. Lattimore. John Giertz made a special presentation, a lifetime membership to C. D. Neill of the Enid, Oklahoma, Board of Trade.

• • • •

Northwest Section assembled for a luncheon meeting at 12 noon on Friday, December 28, at Jax Cafe, Minneapolis. James W. Evans spoke on "Modified Cornstarch and Related Products." Dr. Evans is Director of Research for American Maize Products of Roby, Indiana.

• • • •

Nebraska Section heard three talks at their monthly meeting on November 24 in the Foods and Nutrition Building of the University of Nebraska College of Agriculture. D. W. Conrad of General AM. Transportation Corp. presented the first talk entitled "Bulk Transportation." The other two were given by William Ungashick and Robert Joslin. Mr. Ungashick, of Crissey Company, spoke on "Pneumatic Flour Handling Equipment for the Baking Industries." Dr. Joslin, of Fairmont Foods, spoke on "Rheology of Doughs and Leavening."

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